Greenhouse Gases Concentrations in the Atmosphere Along Selected Roads in Abeokuta, Ogun State, Nigeria

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Abstract
This study investigated effect of vehicular emission on greenhouse gases concentrations along selected roads of different traffic densities in Abeokuta, Ogun State, Nigeria. Nine roads comprised highway, commercial and residential were selected. Greenhouse Gases (GHGs) were determined from both sides of the roads by using gas samplers placed at 1, 5 and 10m away from the roads at different road segments (up/downhill, bend and flat surface) and replicated three times. The data collected were subjected to descriptive statistics and ANOVA. Means were separated using Duncan's Multiple Range test. The concentrations of GHGs were CO_2 >CO > NO_x > NO > SO_x > CH_4 and decreased significantly ($P<0.05$) as distance increased from the road. Highway with significantly ($P<0.05$) highest traffic density had the highest concentrations of NO, NO_x, CO, CO_2, SO_x and CH_4 with 1.51ppm, 2.22ppm, 22.15ppm, 15.33%, 1.43ppm and 0.85ppm respectively followed by the commercial and residential. Up/downhill had the highest concentrations of GHGs among the road segments followed by flat surface and road bend.

***Key words**: Greenhouse gases, vehicular emission, traffic densities*

Introduction

Greenhouse gases such as carbon dioxide, methane, water vapour and nitrous oxide occur naturally in the atmosphere while chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as well as sulphur hexafluoride (SF6) are man made (Kellog, 1996). Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to human activities (Hansen *et al.*, 1999). USEPA (2004) ranked the major greenhouse gases contributing end-user sectors in the following order: industrial, transportation, residential, commercial and agricultural. The large majority of today's cars and truck travel by using internal combustion engines that burn gasoline or other fossil fuels (Prather, 1995).In the process of combustion, a number of changes occur, some of the fuel is passed out unburned; partly burnt fuel changes form into a number of gases, impurities combine in the process principally with air to form other compounds for instant oxides of sulphur (SO_x), nitrogen from air participate in the combustion process to form oxides of nitrogen (NO_x) depending on the prevailing conditions in the combustion chamber. Other gases formed include carbon monoxide (CO), carbon (iv) oxide (CO_2) and methane (CH_4) (Prather *et al.*, 1995). The products of combustion mainly gases and particulates are then emitted into the environment as exhaust gases which may lead to global warming. Besides, these gases in dust pose a risk for children and street traders who spend up to 10hours daily selling their goods. CO affects nervous system, impairing physical coordination, vision and judgments, creating nausea and headaches, reducing productivity and increasing personal discomfort; NO_x increase susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritation and the sulphur dioxide affect lung function adversely (Marland *et al.*, 1999). Abeokuta as a state capital has been experiencing an increase in both population and traffic density. This is evidenced by the continued expansion of central business district, residential areas and traffic congestion at peak hours. Work has been done on the heavy metals in relation to traffic densities (Bada *et al.*, 2001) but much work has not been done in relation to greenhouse gases. The attempt to bridge the gap forms the thrust for this work. The objective of this study was to determine effect of vehicular emission on greenhouse gases concentrations along selected roads of different traffic densities in Abeokuta, Ogun State, Nigeria.

Study area

Abeokuta lies within latitudes 6^0 N to 8^0 N and longitudes $2^030'$E and 5^0E in Southwestern Nigeria. Abeokuta contains few but emerging industries, many commercial centers and schools of various levels of

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learning, hospitals and residential buildings. The main occupation of people in the town is civil service. Other occupations are farming, local textile (tie and dye), trading and pottery .The study was carried out in three residential area roads (Federal Housing Estate Ita-Elega, Asero Housing Estate and Idi-Aba Housing Estate), commercial centre roads (Sapon, Omida and Lafenwa) and highways (Abeokuta-Shagamu Road, Abeokuta-Ilaro Road and Abeokuta-Ibadan Road) and their traffic counts were then carried out (Figure 1).

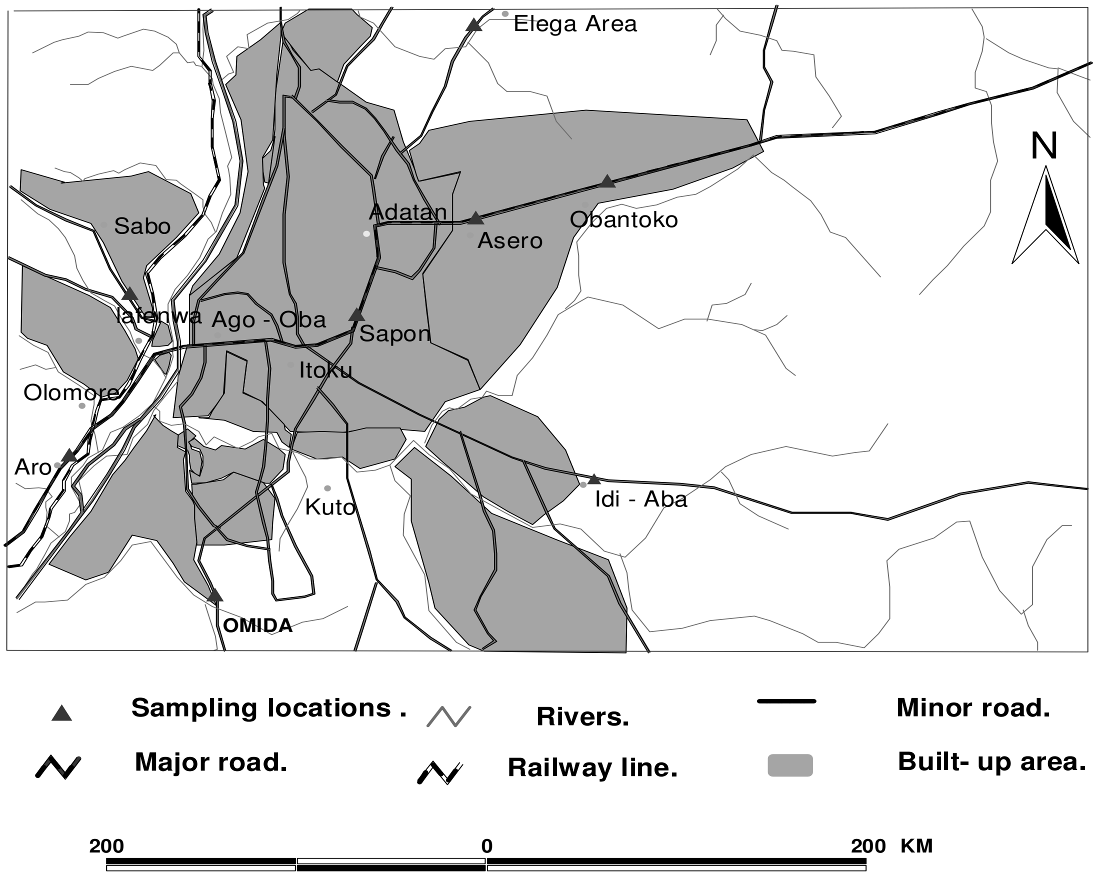

Fig. 1: Map of the study roads

METHODOLOGY

Instruments used

- A tetra multi-gas monitor was used to measure CH_4, CO and H_2S
- For CO_2, NO and NOx, a multi gas meter (Land Duo) was used.
- BW (Model 0539) gas alert was used to measure oxides of sulphur (SO_x)
- Particulate matters were measured by an Aerotrac particulate counter which measures in size range of counts/m^3($\mu m/m^3$)

Sampling

Calibrated gas samplers were used to measure the amount of the pollutant in the atmosphere from both sides of the roads (highway, commercial and residential) at distance of 1, 5 and 10m,away from the edge of the road at various road segments (up/down hill, flat and bend) and replicated three times

Statistical analysis.

Data collected were subjected to descriptive statistics, analysis of variance (ANOVA) and means were separated using Duncan's Multiple Range (DMR) test.

Results and Discussion

The mean traffic densities for highway, commercial and residential were shown in Table 1 with highway having significantly ($P<0.05$) highest traffic density followed by the commercial and residential. The result of this study was similar to the work carried out by Ogunsola *et al*. (1994) along highways and residential roads in Lagos State, Nigeria where highways had higher traffic densities than residential. Table 2 shows the greenhouse gases concentrations with distance away from the roads (highway, commercial and residential). The levels of the greenhouse gases decreased with increased distance from the roads. Concentrations of NO, NO_x, CO, CO_2 and CH_4 at 1m away from the roads were significantly ($P<0.05$) higher than 10m except CO_2 and CH_4 of highway and NO of commercial. Decrease in greenhouse gases concentrations with distance from the road consistent with Haygarth and Jones (1992) findings concerning heavy metal who reported that decreasing metal concentrations with increasing distance from the road might be due to heavy metals emitted from vehicle exhausts in particulate forms which are forced to settle under gravity closer to the road edge.

Greenhouse gases concentrations also varied with traffic densities (Table 2). Highway with significantly ($P<0.05$) highest traffic density had the highest concentrations of the greenhouse gases and particulate matter (as shown in Table 3) followed by the commercial and residential. This is an indication of an enhanced level in the high traffic density surrounding atmosphere. The process of burning gasoline to power cars and trucks contributes to air pollution by releasing a variety of gases such as CO, CO_2 CH_4, SO_x and NO_x (Prather *et al*., 1996). USEPA (2005) stated that cars and light trucks are the largest single source of air pollution in most urban areas, accounting for one quarter of emissions of smog-forming pollutants nationwide. Also related to this study but on heavy metal, Bada *et al*. (2001) observed that the levels of heavy metals in soil and vegetation along roadsides in Osun State, Nigeria varied with traffic volume.

Greenhouse gases concentrations at various segments of the Highway (HYW), Commercial (COM) and Residential (RES) roads were shown in Table 4. Uphill segment had the highest concentration of the greenhouse gases followed by the flat surface and road bend. The high gases concentrations obtained in the atmosphere within the uphill segment of the road could have resulted from increased rate of vehicular emission when ascending a hill and when descending, low level of emission is released because of less power requirement to move the vehicles. However it is obvious that the more energy that is consumed by vehicles, the higher the level of emissions, most of which are deposited closest to the roadside.

Conclusion

The concentrations of greenhouse gases decreased with increased horizontal distance away from the road edge and the extent of greenhouse gases pollution was positively related to traffic volume. Road segments also affected the level of the greenhouse gases in the atmosphere surrounding the roads. Up/downhill had the highest concentrations followed by the flat surface and road bend. To reduce the hazardous effects of greenhouse gases on public health particularly of school children ,roadside mechanics, artisans and street traders who are most vulnerable to traffic pollution, an appropriate land use policy which prohibits the use of roadside lands is required and enforcement of its compliance needs to be vigorously pursued and indeed can be made a national policy. Further step should include the legislation against the use of smoking vehicles to prevent severe environmental pollution.

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Table 1: Traffic densities of highway, commercial and residential.

Road	Traffic density (vehicles/hr)
Highway	2300a
Commercial	1933b
Residential	700c

Means in the same column followed by the same letter are not significantly different at P<0.05 according to DMRT

Table 2: Greenhouse gases concentrations of highway, commercial and residential roads

Gases	Distance (m)	Road		
		Highway	**Commercial**	**Residential**
NO (ppm)	1	1.51a	1.04a	0.94a
	5	1.08b	0.76a	0.63ab
	10	0.69b	0.58a	0.30b
NO_X (ppm)	1	2.22a	1.64a	1.52a
	5	1.40b	1.12b	0.79b
	10	0.85b	0.67c	0.33c
CO (ppm)	1	22.15a	21.07a	18.74a
	5	9.09ab	6.08b	4.00ab
	10	2.22b	1.00b	0.74b
CO_2 (%)	1	15.33a	9.96a	9.67a
	5	5.31a	3.92ab	2.04b
	10	2.37a	0.85b	0.55b
SO_x (ppm)	1	1.43a	0.91a	0.79a
	5	1.25a	0.47a	0.33a
	10	0.60a	0.34a	0.08a
CH_4 (ppm)	1	0.85a	0.80a	0.70a
	5	0.69a	0.61a	0.35b
	10	0.30a	0.22b	0.11b

Means in the same column followed by the same letter are not significantly different at P<0.05 according to DMRT

Table 3: Size range of particulate matter at 1m away from highway, commercial and residential roads.

Road	Size range (counts/m^3)		
	0.3-0.5	0.5-1	1.0-3.0
Highway	853662a	37034a	26439a
Commercial	525582b	33699a	20865ab
Residential	516675b	25792a	11921b

Means in the same column followed by the same letter are not significantly different at P<0.05 according to DMRT

Table 4: Average greenhouse gases concentrations at various road segments

Gases	Distance (m)	Road segments								
		Up / Downhill			Flat			Bend		
		HYW	COM	RES	HYW	COM	RES	HYW	COM	RES
NO (ppm)	1	1.67a	1.34a	1.11a	1.64a	0.89a	0.82a	1.22a	0.89a	0.92a
	5	0.44b	0.67b	0.89b	1.44a	0.89a	0.78a	0.67ab	0.72a	0.88a
	10	0.22b	0.67b	0.44b	0.78b	0.56a	0.78a	0.11c	0.52b	0.61b
NO_x (ppm)	1	2.67a	1.70a	1.68a	2.00a	1.67a	1.56b	2.00a	1.56a	1.33a
	5	0.78b	1.00b	1.33b	1.17b	1.40ab	1.00b	1.18b	1.48a	0.89a
	10	0.22c	0.44c	0.67b	1.00b	0.67b	0.80b	0.56b	0.11b	0.80a
CO (ppm)	1	33.78a	36.22a	33.11a	14.44a	15.22a	15.67a	14.22a	14.56a	8.67a
	5	13.63b	8.17b	4.75b	7.22b	4.00b	3.67b	6.06b	6.42b	3.57b
	10	0.78c	1.67b	1.22b	0.67c	0.56b	2.78c	0.89c	1.11c	2.22b
CO_2 (%)	1	24.56a	14.78a	14.67a	11.33a	8.00a	7.78a	10.11a	7.11a	6.56a
	5	2.22b	1.42b	1.24b	4.22b	2.01b	7.58b	6.14a	2.85b	6.14a
	10	0.67c	0.33b	0.21c	0.56c	1.56b	0.67b	4.89a	1.55b	0.89b
SO_x(ppm)	1	2.37a	1.62a	1.46a	0.60a	0.60a	0.79a	0.60a	2.05a	0.52a
	5	0.89b	0.56b	0.27b	0.31ab	0.19b	0.56ab	0.53a	0.50b	0.32ab
	10	0.33c	0.11c	0.22b	0.22b	0.00c	0.35b	0.23b	0.23b	0.13b
H_4 (ppm)	1	0.89a	0.78a	0.89b	0.86a	0.66a	0.89a	0.82a	0.67a	0.67a
	5	0.61b	0.40ab	0.69ab	0.33b	0.56a	0.56b	0.78a	0.67a	0.50ab
	10	0.33c	0.22b	0.33b	0.11b	0.11b	0.33c	0.23b	0.00b	0.00c

Means in the same column followed by the same letter are not significantly different at P<0.05 according to DMRT